## **Amendments to the Claims**

1. (Original) System for estimating the ground condition under a driving vehicle, comprising:

a wheel speed sensor (4) for sensing a wheel speed signal *(t(n)* , w(*n)*) which is indicative of the wheel speed of a vehicle's wheel driving over the ground (2,3); and

a first analyser unit (8) coupled to said wheel speed sensor (4) which comprises:

a sensor imperfection estimation section (9) which is designed to estimate a sensor imperfection signal ($\delta_1$) from the wheel speed signal *(t(n))* which is indicative of the sensor imperfection of the wheel speed sensor (4);

a signal correction section (10) which is designed to determine an imperfection-corrected sensor signal $(_E(n))$ from the wheel speed signal ($t_n$) and the sensor imperfection signal ($\delta_1$); and

a ground condition estimation section (11) which is designed to estimate a first estimation value *(r(n), α(n))* indicative of the ground condition from the imperfection corrected sensor signal $(_E(n))$.

2. (Original) The system of claim 1, wherein the wheel speed sensor (4) comprises a segmented rotary element (5), and the sensor imperfection estimation section (9) is designed to estimate, at each revolution of the rotary element (5), a sensor imperfection value ($\delta_1$), representative of the sensor imperfection signal for each of the segments (6) of the rotary element (5).

3. (Original) The system of claim 2, wherein the sensor imperfection value ($\delta_1$) is a weighted average of sensor imperfection values *(y(n))* of previous and current revolutions *(n)* of the rotary element.

4. (Previously Presented) The system of claim 1, wherein the sensor imperfection estimation section (9) comprises a low pass filter which is implemented according to the following filter relation:

$$LP: \delta_l = (1 - \mu)\, \delta_{l} + \mu\, \gamma(n),$$

with

$$\gamma(n) = \frac{2\pi}{T_{LAP}(n)}(t(n) - t(n-1)) - \frac{2\pi}{L}$$

wherein $\delta_l$ is an estimation value of the sensor imperfection, $\mu$ is a forgetting factor of the filter, $t(n)$ and $t(n-1)$ is the wheel speed signal, $L$ is the total number of segments (6) of the rotary element (5) and $T_{LAP}(n)$ is the duration of a complete revolution of the rotary element (5).

5. (Previously Presented) The system of claim 1, wherein the ground condition estimation section (II) comprises:

a variance determination section (12) which is designed to determine the variance *(a(n))* of the imperfection-corrected
sensor signal $(_E(n))$, and
a ground condition estimation subsection (13) which is designed to estimate the first estimation value *(r(n))* on the basis of the variance *(a(n))* thus determined.

6. (Previously Presented) The system of claim 5, wherein the variance determination section (12) comprises a low pass filter (16) for determining the variance *(a(n)* of the imperfection-corrected sensor signal $(_\varepsilon(n))$ according to the following relation:

$$a(n) = Var(_\varepsilon) = LP(_\varepsilon^2) - LP(_\varepsilon)^2,$$

wherein $LP(_\varepsilon)$ is a low pass filtered value of the imperfection corrected sensor signal $(_\varepsilon(n))$ and $LP(_\varepsilon^2)$ is a low pass filtered value of the square $(_\varepsilon^2(n))$ of the imperfection-corrected sensor signal $(_\varepsilon)n))$.

7. (Original) The system of claim 6, wherein the low pass filter (16) is implemented according to the following filter relation:

$$LP: a(n+1) = (1-\lambda)\ \alpha(n) + \lambda_{\varepsilon}(n),$$

wherein $\alpha$ is an estimation value of the variance $Var(_{\varepsilon})$, $\lambda$ is a forgetting factor of the filter, and $_{\varepsilon}(n)$ is the imperfection-corrected sensor signal.

8. (Previously Presently) The system of claim 5, wherein the ground condition estimation subsection (13) comprises a signal change determination section (14) which is designed to determine signal change values *(CUSUMCounter(n))* according to the following relation:

$CUSUMCounter(n+1) = min(max(CUSUMCounter(n) + \alpha(n) - Drift, 0), Counter Limit)$, wherein $\alpha(n)$ is the variance obtained from the variance determination section, and *Drift* and *CounterLimit* are tuning parameters.

9. (Original) The system of claim 8, wherein the ground condition estimation subsection (13) further comprises a decision section (15) which is designed to compare the signal change values *(CUSUMCounter(n))* from the signal change determination section (14) with a first and a second threshold value *(set, reset)* and to output a current first estimation value *(r(n))* indicative of a rough road condition if the current signal change value *(CUSUMCounter(n))* is greater than the first threshold value *(set),* a current first estimation value indicative of a normal road condition if the signal change value *(CUSUMCounter(n))* is lower than the second threshold value *(reset),* and otherwise a current first estimation value equal to the previous first estimation value *(r(n-l)).*

10. (Previously Presented) The system of claim 1, which additionally comprises: one first analyser unit (8) for each wheel $(i = FL, FR, RL, RR)$ of the vehicle having more than one wheel, wherein each first analyser unit (8) is designed to provide a first estimation value $(\alpha_i(n))$ indicative of the ground condition under the respective wheel, and

a combination section (17) which is designed to combine the first estimation values

$(\alpha_i n))$ provided from each of the first analyser units (8) in order to obtain a

combined first estimation value $(y(n), I_{hl}(n))$ indicative of the road condition under the vehicle.

11. (Original) The system of claim 10, wherein the combined first estimation value $(y(n), I_{hl}(n))$ is determined by

averaging the first estimation values $(a_i(n))$ provided from each of the first analyser units (8),

using networks of series expansion type, in particular neural networks, radial basis function networks, fuzzy networks, on the basis of the first estimation values $(\alpha_i(n))$,

using a min-function on the basis of the first estimation values $(a_i(n))$, and/or

using a max-function on the basis of the first estimation values $(a_i(n))$.

12. (Previously Presented) The system of claim 8, which additionally comprises: one first analyser unit (8) for each wheel $(i = FL,FR,RL,RR)$ of the vehicle having more than one wheel; and wherein the signal change determination section (14) is coupled to the combination section (17) in order to determine the signal change value *(CUSUMCounter(n))* on the basis of the combined first estimation value $(y(n))$.

13. (Previously Presented) The system of claim 1 comprising:

a second analyser unit (19) which is associated with the wheel speed sensor (4) and designed to determine a second indicative value (β(n)) indicative of the ground condition from the wheel speed sensor (4); and

a decision unit (20) which is designed to determine a combined estimation value $(R(n))$ indicative of the ground condition on the basis of the first and second estimation values $(a(n),\beta(n))$ from the first and second analyser units (8,19), respectively.

14. (Original) The system of claim 13, wherein the second analyser unit (19) comprises:

a band pass or high pass filter section (21) for filtering the wheel speed signal

($w(n)$), and a variance estimation section (12) for determining a variance value ($\beta(n)$) from the filtered wheel speed signal ($w(n)$), wherein the variance value ($\beta(n)$) is indicative of the ground condition under the respective wheel;

a side-wise correlation section which is designed to correlate the wheel speed signals ($w(n)$) of the wheels ($i = FL,FR,RL,RR$) on a first side of the vehicle (1) with the wheel speed signals ($w(n)$) of the wheels ($i = FL,FR,RL,RR$) on a second side of the vehicle (1), wherein the correlation value ($r(n)$) is indicative of the ground condition;

an axle-wise correlation section which is designed to correlate the wheel speed signals ($w(n)$) of the wheels $i=FL,FR,RL,RR$) on a first axle of the vehicle (1) with the wheel speed signals ($w(n)$) of the wheels ($i = FL,FR,RL,RR$) on a second axle of the vehicle (1), wherein the correlation value ($r(n)$) is indicative of the ground condition; or

a frequency determination section which is designed to determine the highest Fourier frequency ($r(n)$) of the wheel speed signal ($w(n)$) which is indicative of the ground condition.

15. (Previously Presented) The system of claim 13, comprising:

one first analyser unit (8) for each wheel ($i = FL,FR,RL,RR$) of the vehicle having more

than one wheel, wherein each first analyser unit (8) is designed to provide a first estimation value ($\alpha_i(n)$) indicative of the ground condition under the respective wheel, and

a first combination section (17) which is designed to combine the first estimation values ($\alpha_i(n)$) provided from each of the first analyser units (8) in order to obtain a combined first estimation value ($\gamma(n)$) indicative of the road condition under the vehicle;

a signal change determination section (14) which is designed to determine signal change values ($CUSUMCounter(n)$) on the basis of the combined first estimation values ($\gamma(n)$) according to the following relation:

$CUSUMCounter(n+1) = \min(\max(CUSUMCounter(n) + \gamma(n) - Drift, 0), CounterLimit)$, wherein $Drift$ and $CounterLimit$ are turning parameters;

one second analyser unit (19) for each wheel ($i = FL, FR, RL, RR$) of the vehicle, wherein

each second analyser unit (19) is designed to provide a second estimation value ($\beta_i(n)$) indicative of the ground condition under the respective wheel, and

a second combination section (17) which is designed to combine the second estimation values ($\beta_i(n)$) provided from each of the second analyser units (19) in order to obtain a combined second estimation value ($r_2(n)$) indicative of the road condition under the vehicle

an output combination section (22) for combining the signal change values ($CUSUMCounter(n)$) and the second combined estimation values ($r_2(n)$) in order to obtain a combined estimation value ($\Omega(n)$ , $R(n)$) indicative of the road condition under the vehicle.

16. (Previously Presented) The system of claim 13, comprising:

one first analyser unit (8) for each wheel ($i = FL, FR, RL, RR$) of the vehicle having more than one wheel, wherein each first analyser unit (8) is designed to provide a first estimation value ($\alpha_i(n)$) indicative of the ground condition under the respective wheel, and

a first combination section (17) which is designed to combine the first estimation values ($\alpha_i(n)$) provided from each of the first analyser units (8) in order to obtain a combined first estimation value ($r_1(n)$) indicative of the road condition under the vehicle;

one second analyser unit (19) for each wheel ($i = FL, FR, RL, RR$) of the vehicle, wherein each second analyser unit (19) is designed to provide a second estimation value ($\beta_i(n)$) indicative of the ground condition under the respective wheel, and

a second combination section (17) which is designed to combine the second estimation values ($\beta_i(n)$) provided from each of the second analyser units (19) in order to obtain a combined second estimation value ($r_1(n)$) indicative of the road condition under the vehicle

an output combination section (22) for combining the first and second combined estimation values ($r_1(n)$ , $r_2(n)$) in order to obtain a combined estimation value ($\Omega(n)$) indicative of the road condition under the vehicle; and

a signal change determination section (14) which is designed to determine signal change values (*CUSUMCounter(n)*) on the basis of the combined estimation values ($\Omega(n)$) from the output combination section (22) according to the following relation:

$CUSUMCounter(n+1) = \min(\max(CUSUMCounter(n) + \Omega(n) - Drift, 0), CounterLimit)$, wherein *Drift* and *CounterLimit* are turning parameters.

17. (Previously Presented) The system of claim 15, further comprising a decision section (15) which is designed to compare the signal change values *(CUSUMCounter(n))* from the signal change determination section (14) with a first and a second threshold value *(set, reset)* and to output a current first estimation value *(r(n))* indicative of a rough road condition if the current signal change value *(CUSUMCounter(n))* is greater than the first threshold value *(set),* a current first estimation value indicative of a normal road condition if the signal change value *(CUSUMCounter(n))* is lower than the second threshold value *(reset),* and otherwise a current first estimation value equal to the previous first estimation value *(r(n-l)).*

18. (Original) Method for estimating the ground condition under a driving vehicle, comprising the steps of:

sensing a wheel speed signal ($t(n)$ , $\omega(n)$) by means of a wheel speed sensor (4) which is indicative of the wheel speed of a vehicle's wheel driving over the ground (2,3); and

estimating a sensor imperfection signal ($\delta_1$) from the wheel speed signal ($t(n)$) which is indicative of the sensor imperfection of the wheel speed sensor (4);

determining an imperfection-corrected sensor signal ($\varepsilon(n)$) from the wheel speed signal ($t(n)$) and the sensor imperfection signal ($\delta_1$); and

estimating a first estimation value ($r(n)$ , $\alpha(n)$) indicative of the ground condition from the imperfection-corrected sensor signal ($\varepsilon(n)$).

19. (Original) The method of claim 18, wherein the step of estimating the sensor imperfection signal ($\delta_l$) from the wheel speed signal ($t(n)$) comprises estimating, at each revolution of the rotary element (5), a sensor imperfection value ($\delta_l$) representative of the sensor imperfection signal for each of the segments (6) of a rotary element (5).

20. (Original) The method of claim 19, wherein the sensor imperfection value ($\delta_l$) is a weighted average of sensor imperfection values ($\gamma(n)$) of previous and current revolutions ($n$) of the rotary element.

21. (Previously Presented) The method of claim 18, wherein the step of estimating the sensor imperfection signal ($\delta_l$) from the wheel speed signal ($t(n)$) comprises a step of low pass filtering according to the following filter relation:

$$LP: \delta_l = (1 - \mu)\, \delta_l + \mu\, \gamma(n),$$

wherein

$$\gamma(n) = \frac{2\pi}{T_{LAP}(n)}(t(n) - t(n-1)) - \frac{2\pi}{L}$$

wherein $\delta_l$ is an estimation value of the sensor imperfection, $\mu$ is a forgetting factor of the filter, $t(n)$ and $t(n\text{-}1)$ is the wheel speed signal, $L$ is the total number of segments (6) of the rotary element (5) and $T_{Lap}(n)$ is the duration of a complete revolution of the rotary element (5).

22. (Previously Presented) The method of claim 18, further comprising the steps of:

determining a variance ($\alpha(n)$) of the imperfection-corrected sensor signal ($\varepsilon(n)$) , and

estimating the first estimation value ($r(n)$) on the basis of the variance ($\alpha(n)$) thus determined.

23. (Currently amended) The method of claim 18, wherein the step of determining a variance ($\alpha(n)$) of the imperfection-corrected sensor signal ($\varepsilon(n)$) comprises the step of low pass filtering the imperfection-corrected sensor signal ($\varepsilon(n)$) according to the following relation:

$$\alpha\ (n)) = \mathrm{Var}(\varepsilon) = LP(\varepsilon^2) - LP(\varepsilon)^2\ ,$$

wherein $LP(\varepsilon)$ is a low pass filtered value of the imperfection-corrected sensor signal ($\varepsilon(n)$) and $LP(\varepsilon^2)$ is a low pass filtered value of the square ($\varepsilon^2(n)$) of the imperfection-corrected sensor signal ($\varepsilon(n)$).

24. (Original) The method of claim 23, wherein the low pass filtering is implemented according to the following filter relation:

$$LP\!:\ \alpha\ (n+1) = (1-\lambda)\ \alpha(n) + \lambda\ \varepsilon(n)\ ,$$

wherein $\alpha$ is an estimation value of the variance $Var(\ \varepsilon)$ , $\lambda$ is a forgetting factor of the filter, and $\varepsilon(n)$is the imperfection-corrected sensor signal.

25. (Previously Presented) The method of one claim 18, further comprising the step of determining signal change values ($CUSUMCounter(n)$) according to the following relation:

$$CUSUMCounter(n+1) = \min(\max(CUSUMCounter(n) + \alpha\ (n) - Drift, 0), CounterLimit),$$

wherein $\alpha\ (n)$ is the variance obtained from the variance determination section, and *Drift* and *CounterLimit* are tuning parameters.

26. (Previously Presented) The method of claim 25, further comprising comparing the signal change values ($CUSUMCounter(n)$) with a first and a second threshold value (*set,reset* and outputting a current first estimation value ($r(n)$) indicative of a rough road condition if the current signal change value ($CUSUMCounter(n)$) is greater than the first threshold value (*set*), a current first estimation value indicative of a normal road condition if the signal change value ($CUSUMCounter(n)$) is lower than the second threshold value

(*reset*), and otherwise a current first estimation value equal to the previous first estimation value ($r(n-1)$).

27. (Previously Presented) The method of claim 18, further comprising:

providing a first estimation value ($\alpha_1(n)$) indicative of the ground condition under the respective wheel for each wheel ($i = FL, FR, RL, RR$) of the vehicle having more than one wheel, and

combining the first estimation values ($\alpha_1(n)$) in order to obtain a combined first estimation value ($\gamma(n)$ , $I_{h1}(n)$) indicative of the road condition under the vehicle.

28. (Currently Amended) The method of claim 27, wherein the combined first estimation value ($\gamma(n)$ , $I_{h1}(n)$) is determined by

averaging the first estimation values ($\alpha_1(n)$) ~~provided from each of the first analyser units (8)~~,

using networks of series expansion type, in particular neural networks, radial basis function networks, fuzzy networks, on the basis of the first estimation values ($\alpha_1(n)$) , and/or

using a min-function on the basis of the first estimation values ($\alpha_1(n)$) , and/or.

using a max-function on the basis of the first estimation values ($\alpha_1(n)$) .

29. (Previously Presented) The method of claim 27 wherein the ground condition estimation subsection (13) comprises a signal change determination section (14) which is designed to determine signal change values (*CUSUMCounter(n)*) according to the following relation:

$CUSUMCounter(n+1) = min(max(CUSUMCounter(n) + \alpha(n) - Drift, 0), Counter Limit)$ , wherein $\alpha(n)$ is the variance obtained from the variance determination section, and *Drift* and *CounterLimit* are tuning parameters; and further wherein a signal change value (*CUSUMCounter(n)*) is determined on the basis of the combined first estimation value ($\gamma(n)$ .

30. (Previously Presented) The method of claim 18, further comprising the steps of:

determining a second estimation value ( $\beta(n)$) indicative of the ground condition from the wheel speed signal ( $\omega(n)$) received from the wheel speed sensor (4); and

determining a combined estimation value ( $R(n)$) indicative of the ground condition on the basis of the first and second estimation values ($\alpha_1(n)$ ,( $\beta(n)$) .

31. (Original) The method of claim 30, further comprising:

filtering the wheel speed signal ( $\omega(n)$) with a band pass or high pass filter, and determining a variance value ( $\beta(n)$) from the filtered wheel speed signal ( $\tilde{\omega}(n)$) , wherein the variance value ( $\beta(n)$) is indicative of the ground condition under the respective wheel;

correlating the wheel speed signals ( $\omega(n)$) of the wheels ($i = FL,FR,RL,RR$) on a first side of the vehicle (1) with the wheel speed signals ( $\omega(n)$) of the wheels ($i = FL,FR,RL,RR$) on a second side of the vehicle (1), wherein the correlation value ($r(n)$) is indicative of the ground condition;

correlating the wheel speed signals ( $\omega(n)$) of the wheels ($i = FL,FR,RL,RR$) on a first axle of the vehicle (1) with the wheel speed signals ( $\omega(n)$) of the wheels ($i = FL,FR,RL,RR$) on a second axle of the vehicle (1), wherein the correlation value ($r(n)$) is indicative of the ground condition; or

determining the highest Fourier frequency ($r(n)$) of the wheel speed signal ( $\omega(n)$) which is indicative of the ground condition.

32. (Previously Presented) The method of claim 31, comprising the steps of:

providing a first estimation value ($\alpha_1(n)$) indicative of the ground condition under the respective wheel, for each wheel ($i = FL,FR,RL,RR$) of the vehicle having more than one wheel; and

combining the first estimation values ($\alpha_1(n)$) in order to obtain a combined first estimation value ( $\gamma(n)$) indicative of the road condition under the vehicle;

determining signal change values (*CUSUMCounter(n)*) on the basis of the first estimation values ($\gamma(n)$) according to the following relation:

$$(CUSUMCounter(n+1) = \min(\max(CUSUMCounter(n) + (\gamma(n)) - Drift, 0), CounterLimit),$$

wherein *Drift* and *CounterLimit* are turning parameters;

providing a second estimation value ( $\beta(n)$) indicative of the ground condition under the respective wheel, for each wheel ($i = FL,FR,RL,RR$) of the vehicle; and

combining the second estimation values ( $\beta(n)$) in order to obtain a combined second estimation value ($r_2(n)$) indicative of the road condition under the vehicle;

combining the signal change values ( *CUSUMCounter(n)*) and the second combined estimation values ($r_2(n)$) in order to obtain a combined estimation value ( $\Omega(n)$ , $R(n)$) indicative of the road condition under the vehicle.

33. (Previously Presented) The method of claim 30, comprising:

for each wheel ($i = FL,FR,RL,RR$) of the vehicle having more than one wheel, providing a first estimation value ($\alpha_1(n)$) indicative of the ground condition under the respective wheel; and

combining the first estimation values ($\alpha_1(n)$) in order to obtain a combined first estimation value ($r_1(n)$) indicative of the road condition under the vehicle;

for each wheel ($i = FL,FR,RL,RR$) of the vehicle, providing a second estimation value ($\beta_1(n)$) indicative of the ground condition under the respective wheel; and

combining the second estimation value ($\beta_1(n)$) in order to obtain a combined second estimation value ($r_2(n)$) indicative of the road condition under the vehicle

combining the first and second combined estimation values (($r_1(n)$) , ($r_2(n)$) in order to obtain a combined estimation value ( $\Omega(n)$) indicative of the road condition under the vehicle; and

determining signal change values ( *CUSUMCounter(n)*) on the basis of the combined estimation values ( $\Omega(n)$) according to the following relation:

$$(CUSUMCounter(n+1) = \min(\max(CUSUMCounter(n) + (\Omega(n)) - Drift, 0), CounterLimit),$$

wherein *Drift* and *CounterLimit* are turning parameters;

34. (Previously Presented) The method of claims 33, further comprising the steps of comparing the signal change values (*CUSUMCounter(n)*) with a first and a second threshold value (*set,reset* and outputting a current first estimation value (*r(n)*) indicative of a rough road condition if the current signal change value (*CUSUMCounter(n)*) is greater than the first threshold value (*set*), a current first estimation value indicative of a normal road condition if the signal change value (*CUSUMCounter(n)*) is lower than the second threshold value (*reset*), and otherwise a current first estimation value equal to the previous first estimation value ($r(n - 1)$).

35. (Original) A computer program including program code for carrying out a method, when executed on a processing system, of estimating the ground condition under a driving vehicle, the method comprising the steps of:

sensing a wheel speed signal ($t(n)$ , $\omega(n)$) by means of a wheel speed sensor (4) which is indicative of the wheel speed of a vehicle's wheel driving over the ground (2,3); and

estimating a sensor imperfection signal ( $\delta_1$ ) from the wheel speed signal ($t(n)$) which is indicative of the wheel speed sensor (4);

determining an imperfection-corrected sensor signal ($\varepsilon(n)$) from the wheel speed signal ($t(n)$) and the sensor imperfection signal ($\delta_1$) ; and

estimating a first estimation value ($r(n)$ , $\alpha(n)$) indicative of the ground condition from the imperfection-corrected sensor signal ($\varepsilon(n)$) .